coating formed by a process consisting essentially of plasma spraying a coating material on a plasma exposed surface of the component, wherein the coating has an as-sprayed surface roughness that promotes the adhesion of polymer deposits.

REMARKS

Claims 1-34 are pending. By this Amendment, Claims 1 and 14 are amended and new Claims 32-34 are added. The specification is amended to address the objection set forth at paragraph 3 of the Official Action and several minor informalities. Reconsideration of the February 26, 2002 Official Action is respectfully requested.

Applicants reaffirm the election with traverse to prosecute the subject matter of Claims 14-31. Claims 1-13 were withdrawn from consideration as being drawn to non-elected subject matter. Claim 1 is directed to a method of making a plasma reactor component and recites all of the limitations recited in Claim 14, which is directed to a plasma reactor component (i.e., a product). According to MPEP § 821.04, once Claim 14 is determined to be allowable, Claim 1 (and Claims 2-13 dependent therefrom) must be rejoined and examined in this application. New Claims 32-34 are drawn to the elected invention.

Claims 14-22 and 25-31 were rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 6,120,640 to Shih et al. ("Shih") in view of U.S. Patent No. 5,916,454 to Richardson et al. ("Richardson") and U.S. Patent No. 5,993,594 to Wicker et al. ("Wicker"). The reasons for the rejection are set forth in numbered paragraph 5 of the Official Action. Shih is cited for disclosure of a plasma etch chamber comprised of bulk boron carbide or a

coating of thermally sprayed boron carbide over a base material (see page 4 of Official Action). In the paragraph bridging pages 5 and 6 of the Official Action, it is acknowledged that Shih does not suggest a plasma reactor with a plasma sprayed coating that has surface roughness characteristics that promote adhesion of polymer deposits. However, the Official Action asserts that Richardson cures the deficiencies of Shih. This rejection is respectfully traversed.

Claim 14 recites a component of a plasma reactor "having one or more surfaces exposed to the plasma during processing, the component comprising an as-sprayed plasma sprayed coating on a plasma exposed surface of the component, wherein the coating has an as-sprayed surface roughness that promotes the adhesion of polymer deposits" (emphasis added). According to the invention, the coating on the plasma exposed surface of the component is formed by a plasma spraying process, which produces an as-sprayed coating having an as-sprayed surface roughness that promotes adhesion of polymer deposits on the coating. Consequently, such polymer deposits have a reduced tendency to flake or peel off of the plasma exposed chamber surface, thus reducing the level of particulate contamination in the plasma reactor.

As explained at page 2, lines 15-24 of the specification, some plasma etching techniques utilize polymer forming species, which can deposit on the interior surface of plasma exposed components of the etch chamber. These polymer deposits can flake or peel off of the interior surfaces and become a source of particle contamination in the plasma reactor. The deposits can contaminate substrates processed in the plasma reactor and consequently reduce processing yields.

The Official Action asserts that the "plasma sprayed coating" recited in Claim 14 is a product-by-process limitation that does not appear to further limit the structure of the product. Applicants submit that Claim 14 is not a product-by-process claim, but rather is a "pure product" claim, because the recited "as-sprayed plasma sprayed coating" describes the product more by its structure than by the process used to obtain it. See In re Garnero, 162 USPQ 221, 223 (CCPA 1969). That is, the "as-sprayed plasma sprayed coating" of the component recited in Claim 14 has novel and unobvious structural characteristics, i.e., "an as-sprayed surface roughness that promotes adhesion of polymer deposits." The cited references fail to suggest the combination of features recited in Claim 14, including an as-sprayed plasma sprayed coating that has such recited structural features.

Shih discloses a plasma etch reactor including interior surfaces facing the plasma that are composed of boron carbide. The boron carbide may be a bulk sintered body, or a coating layer on a chamber part (see the Abstract of Shih). Shih also discloses that silicon nitride can be used (col. 10, lines 50-65) as an alternative material. The boron carbide surfaces are provided by Shih to avoid problems associated specifically with alumina coatings in plasma reactors (col. 2, lines 1-65) and to provide erosion resistance. Shih does not suggest that the coatings reduce the problem of contamination caused by the peeling off of polymer deposits from plasma exposed surfaces of plasma reactors.

Shih discloses that the boron carbide coatings can be thermally sprayed. Plasma spraying is disclosed as one such thermal spray process (see col. 7, lines 21-30 of Shih). However, the Official Action acknowledges that Shih does not teach a plasma reactor component with a coating that has a surface roughness that promotes the adhesion of

polymer deposits. In fact, Shih teaches away from the claimed invention because Shih seeks to provide a smooth surface. Although Shih discloses that surfaces on which the boron carbide coatings are formed by thermal spraying are preferably roughened to enhance sticking of the coating (see col. 8, lines 48-53), Shih does not suggest roughening the coatings themselves. To the contrary, Shih discloses that boron carbide spray coatings applied over a roughened anodized surface have a relatively smooth surface relative to that of the roughened surface (col. 9, lines 21-22).

Further, in an embodiment where Shih discloses that the boron carbide coatings can be deposited by chemical vapor deposition, Shih expressly discloses that such coatings having a bumpy surface should be polished to provide "a much smoother surface" (emphasis added, see the paragraph bridging cols. 9 and 10).

There is no suggestion in Shih to form as-sprayed plasma sprayed coatings with an as-sprayed surface roughness that promotes the adhesion of polymer deposits. Moreover, in light of Shih's disclosure that smooth plasma exposed interior surfaces are desired, Shih would have led one having ordinary skill in the art directly away from the component recited in Claim 14.

Richardson fails to cure the deficiencies of Shih with respect to the component recited in Claim 14. Richardson discloses plasma processing chambers that include interior parts having a surface with a minimum and a maximum roughness specification. Richardson discloses roughening the interior surface of RF window 120, which is made of a dielectric material (col. 6, line 33 to col. 7, line 58). The resulting roughness promotes adhesion of byproduct particles produced by plasma processing to the surface. Richardson

discloses that surfaces of chamber interior parts can be roughened by chemical etching, bead blasting (col. 6, lines 1-6), or by plasma as part of the manufacturing process (col. 6, lines 20-26). However, Richardson does not suggest forming coatings by plasma spraying. Thus, Richardson does not suggest forming an as-sprayed plasma sprayed coating that "has an as-sprayed surface roughness that promotes the adhesion of polymer deposits." Therefore, because Richardson discloses various surface roughening treatments and Shih discloses various surface smoothing treatments, the combination of Shih and Richardson cannot possibly suggest an as-sprayed plasma sprayed coating that has a surface roughness as recited in Claim 14.

Wicker is cited for the disclosure of using hydrofluorocarbons as the processing gas to etch silicon. However, that disclosure fails to cure the above-described deficiencies of Shih and Richardson with respect to the component recited in Claim 14.

Therefore, Claim 14 is patentable over the cited references. Claims 15-22 and 25-31 depend from Claim 14 and thus are also patentable for at least the same reasons as Claim 14. For example, Shih teaches away from the combination of features recited in Claim 21, which recites that the component <u>and</u> the coating material comprise the <u>same</u> ceramic material. As explained at page 8, line 25 to page 9, line 5 of the specification, using the same ceramic material can minimize or eliminate differences in the coefficient of thermal expansion, thereby reducing exfoliation. In contrast, Shih forms boron carbide coatings (i.e., ceramic coatings) on metal substrates that preferably have been roughened to promotive adhesion of the coatings. Shih does not suggest forming the boron carbide

coatings on boron carbide substrates, i.e., on the same material. Accordingly, Claim 21 is clearly patentable over the cited references.

For the foregoing reasons, withdrawal of the rejection of Claims 14-22 and 25-31 is therefore respectfully requested.

Claims 23 and 24 were rejected under 35 U.S.C. § 103(a) over U.S. Publication No. 2001/0003298A1 to Shamouilian et al. ("Shamouilian") in view of Richardson. The reasons for the rejection are set forth in numbered paragraph 6 of the Official Action. However, Examiner Uhlir informed Applicants' undersigned representative during the telephone conference on March 27, 2002 that Claims 14 and 19 should also have been included in this ground of rejection. Accordingly, the rejection of Claims 14, 19, 23 and 24 is respectfully traversed for the following reasons.

Shamouilian is cited for disclosure of a support for a substrate, which includes a dielectric (polyimide layer) covering a primary electrode (Official Action at page 7). Richardson is cited for disclosure of a roughened plasma reactor part. The Official Action asserts that it would have been obvious to roughen the polyimide layer of Shamouilian. However, as explained below, the polyimide layer of Shamouilian is covered by a wafer during processing and thus roughening the polyimide layer would not improve polymer adhesion, because polymer byproducts are prevented from reaching the polyimide layer by the wafer covering the polyimide layer.

Shamouilian discloses an apparatus 20 for processing substrates, including a support 55 comprising a dielectric 60 having a surface 75 on which a substrate 25 is received (see page 2, paragraph 28). As shown in Figure 1 of Shamouilian, the substrate 25 covers the

entire surface 75 of the dielectric 60. Shamouilian discloses that the base 130 and substrate 25 are preferably matched with respect to their shape and size (see page 2, paragraph 29). Because the surface 75 is not a plasma exposed surface, as recited in Claim 14, Shamouilian and Richardson do not suggest the component recited in Claim 14. See MPEP § 2143.03. Accordingly, the component of Claim 14 is clearly patentable over the combination of Shamouilian and Richardson. Claims 19, 23 and 24 depend from Claim 14 and thus are also patentable for at least the same reasons stated above for Claim 14. Therefore, Applicants respectfully request the withdrawal of this rejection.

New Claims 32 and 33 depend from Claim 14 and are also patentable over the cited references for at least the reasons stated above for Claim 14. For example, Claim 32 recites that the component comprises a ceramic material. As explained above, Shih discloses forming the boron carbide or silicon nitride coatings only on metals.

Independent Claim 34 is directed to a component of a plasma reactor, "having one or more surfaces exposed to the plasma during processing, <u>the component comprising a coating formed by a process consisting essentially of plasma spraying a coating material on a plasma exposed surface of the component</u>, wherein the coating has <u>an as-sprayed surface roughness</u> that promotes the adhesion of polymer deposits" (emphasis added). Accordingly, the coating formed on the plasma exposed surface of the component recited in Claim 34 is formed by a process that comprises the recited plasma spraying and only those steps that do not materially affect the basic and novel characteristics of the coating. See MPEP § 2111.03. Shih does not suggest forming a plasma sprayed coating having an as-sprayed surface roughness that promotes the adhesion of polymer deposits by any process.

Thus, Shih does not suggest the claimed component, which includes a coating formed by process consisting essentially of plasma spraying a coating material on a plasma exposed surface of the component. Therefore, Claim 34 is also patentable over the cited references.

Therefore, it is submitted that the differences between the claimed subject matter and the cited references are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to one having ordinary skill in the art.

For the foregoing reasons, Applicants respectfully submit that the application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: Edward A. Brown

Edward A. Brown
Registration No. 35,033

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Date: April 19, 2002

Attachment to Amendment dated April 19, 2002

Marked-up Copy

Paragraph Beginning at Page 10, Line 18

An exemplary metal etch reactor of the aforementioned type is a transformer coupled plasma reactor known as the TCP™ 9600 plasma reactor, which is available from Lam Research Corporation of Fremont, California. FIG. 2 illustrates a simplified schematic of the TCP™ 9600 plasma reactor. In FIG. 2, a reactor 150 including a plasma processing chamber 152 is shown. Above chamber 152, there is disposed an antenna 156 to generate plasma, which is implemented by a planar coil in the example of FIG. 2. The [RF coil] antenna 156 is typically energized by an RF generator 158 via a matching network (not shown). Within chamber 152, there is provided a showerhead 154, which preferably includes a plurality of holes for releasing gaseous source materials, e.g., the etchant source gases, into the RF-induced plasma region between the showerhead and wafer 170.

Paragraph Beginning at Page 12, Line 3

The reactor components of the present invention can also be used in a high-density oxide etch process. An exemplary oxide etch reactor is the TCP 9100™ plasma etch reactor available from [LAM] Lam Research Corporation of Fremont, California. In the TCP 9100™ reactor, the gas distribution plate is a circular plate situated directly below the TCP™ window which is also the vacuum sealing surface at the top of the reactor in a plane above and parallel to a semiconductor wafer. The gas distribution ring feeds gas from a source into the volume defined by the gas distribution plate. The gas distribution plate contains an array of holes of a specified diameter which extend through the plate. The spatial distribution of the holes through the gas distribution plate can be varied to optimize etch uniformity of the layers to be etched, e.g., a photoresist layer, a silicon dioxide layer and an underlayer material on the wafer. The cross-sectional shape of the gas distribution plate can be varied to manipulate the distribution of RF power into the plasma in the

Attachment to Amendment dated April 19, 2002

Marked-up Copy

reactor. The gas distribution plate material is made from a dielectric material to enable coupling of this RF power through the gas distribution plate into the reactor. Further, it is desirable for the material of the gas distribution plate to be highly resistant to chemical sputter-etching in environments such as oxygen or a hydro-fluorocarbon gas plasma in order to avoid breakdown and the resultant particle generation associated therewith.

Attachment to Amendment dated April 19, 2002

Marked-up Claims 1 and 14

1. (Amended) A method of making a plasma reactor component having one or more surfaces which are exposed to plasma during use, the method comprising plasma spraying a coating material onto a plasma exposed surface of the component to form [a] an as-sprayed coating having an as-sprayed surface roughness [characteristics] that [promote] promotes the adhesion of polymer deposits.

14. (Amended) A component of a plasma reactor, the component having one or more surfaces exposed to the plasma during processing, the component comprising [a] an as-sprayed plasma sprayed coating on a plasma exposed surface [thereof] of the component, wherein the coating has an as-sprayed surface roughness [characteristics] that [promote] promotes the adhesion of polymer deposits.